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Knowledge Integration Model of Blockchain Technology in Higher Learning Institutions: A Rasch Measurement Model Approach for Pilot Study

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Article Info

Article history:

Received: 20 August 2025

Accepted: 20 January 2026

Published: 15 Mac 2026

Academic Editor:

Fauziah Abdul Wahid

Malaysian Journal of Science,
Health & Technology

MJoSHT2025, Volume 11, Special Issue
on the 5th International Conference on
Recent Advancements in Science and
Technology (ICoRAST 2025):

Responsible Artificial Intelligence –
Advancing Science and Technology for
Humanity

eISSN: 2601-0003

<https://doi.org/10.33102/mjosht.527>

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Abstract— Blockchain technology has emerged as a transformative tool in higher education, offering secure, transparent, and tamper-proof systems for credential verification, academic record management, and institutional data governance. Despite its potential, adoption remains limited due to technical, financial, and organizational barriers, alongside a lack of validated measurement tools to assess readiness and integration. This pilot study aims to validate an instrument grounded in the Knowledge Integration Model of Blockchain Technology for Higher Learning Institutions using the Rasch Measurement Model. A 50 item survey was administered to 31 purposively sampled stakeholders, including academics, researchers, and postgraduate students with blockchain related experience. Data analysis using WINSTEPS 3.92.1 assessed reliability, item-person fit, unidimensionality, and targeting through Wright Map analysis. The results showed satisfactory reliability (person = 0.82; item = 0.77). Four items (B5, B6, D8, C7) exceeded the acceptable outfit MNSQ threshold (>1.5) and were revised to enhance instrument quality. However, several items showed misfit and require refinement, and the Wright Map indicated a need for more challenging items to better target high ability respondents. Unidimensionality testing revealed a dominant construct with minor secondary dimensions, suggesting further refinement for conceptual clarity. These findings provide preliminary evidence the instrument's potential for large scale application, providing a foundation for assessing blockchain knowledge integration and guiding policy and strategic implementation in higher education.

Keywords— Blockchain technology; higher education; knowledge integration model; Rasch Measurement Model; instrument validation; pilot study.

I. INTRODUCTION

Blockchain technology, defined as a decentralized and cryptographically secured digital ledger, has evolved beyond its original use in cryptocurrencies to encompass applications across various sectors such as supply chain management, healthcare, and education. In higher education, blockchain has gained significant attention for its potential to revolutionize credential verification, safeguard academic records, enhance data security, and promote transparency in administrative processes [1]. By enabling tamper-proof and verifiable transactions, blockchain provides a novel approach to managing institutional data while fostering trust among stakeholders [2]. Despite these promising applications, the adoption of blockchain technology in higher learning institutions remains at a nascent stage and faces numerous challenges, including scalability limitations, lack of interoperability standards, high implementation costs, and resistance to change among stakeholders. Moreover, there is often a knowledge gap among decision makers, educators, and students regarding blockchain's operational mechanisms and integration into existing systems [3-6]. Without addressing these issues, blockchain adoption risks being fragmented and failing to achieve its transformative potential in education [7].

To address these challenges, scholars have proposed knowledge integration frameworks specifically tailored to higher education contexts [1, 3]. These frameworks outline strategic pathways for integrating blockchain into institutional processes by considering governance structures, technological readiness, and collaborative engagement among stakeholders. Building on these theoretical foundations, this study employs the Knowledge Integration Model of Blockchain Technology for Higher Learning Institutions (KIBCK). The KIBCK model conceptualizes blockchain adoption as a multidimensional process encompassing knowledge acquisition, assimilation, transformation, and application across organizational levels. It ensures that blockchain implementation aligns with institutional culture, stakeholder competencies, and governance mechanisms facilitating effective and sustainable integration.

Although conceptual models such as KIBCK have been developed to guide blockchain integration in higher education, they remain largely untested in empirical settings, especially regarding measurement validity [8]. There is a lack of psychometrically validated instruments that can reliably measure institutional readiness, integration level, and barriers to blockchain adoption. This limitation restricts policymakers and institutional leaders from making data-driven decisions, evaluating preparedness, or monitoring progress toward successful blockchain implementation. Consequently, there is a critical need to develop and validate reliable instruments that operationalize the constructs within the KIBCK model.

To bridge this methodological gap, the present pilot study proposes the development and validation of an instrument based on the KIBCK model using the Rasch Measurement Model. The Rasch model offers a rigorous framework for assessing survey instrument quality by examining item functioning, respondent fit, and the alignment of item difficulty with respondent ability [8]. Although the Rasch model has been widely applied in educational and

psychometric research, few studies have employed it to validate instruments measuring blockchain integration in higher education. Therefore, this study aims to pilot-test the KIBCK based instrument using Rasch analysis to ensure validity and reliability. The findings will contribute to refining the instrument and establishing a robust foundation for large scale research and policymaking related to blockchain adoption in higher learning institutions.

II. LITERATURE REVIEW

Blockchain technology, a decentralized and immutable ledger system, has gained significant traction beyond its financial origins, finding promising applications within higher education. Studies reveal its potential to enhance academic processes by ensuring secure credential verification, maintaining academic integrity, and enabling decentralized recordkeeping [9]. Systematic reviews also examine how blockchain can transform administrative operations in universities streamlining certificate issuance, improving transparency, and reinforcing trust among stakeholders [10].

The integration of blockchain within higher learning institutions entails more than technical deployment which it requires framing how institutional knowledge and processes align with new technology. A recent Systematic Literature Review (SLR) proposed a Knowledge Integration (KI) Model specifically for higher education, drawing upon studies spanning 2020–2024 to analyze blockchain's benefits, challenges, and integration strategies [11]. The review applied the PRISMA framework to identify blockchain's potential in enhancing academic credential verification, data security, and institutional knowledge management, while also addressing barriers such as regulatory uncertainty, interoperability challenges, and limited organisational readiness. Synthesising findings through the Technology–Organisation–Environment (TOE) framework, the authors proposed the Knowledge Integration of Blockchain Technology (KIBCK) model, which positions knowledge Integration (KI) as a mediator between contextual factors and blockchain adoption. The model emphasizes technological attributes (security, transparency, data integrity), organizational factors (leadership, resources, readiness), and environmental influences (policy, industry collaboration, societal expectations). The study concludes that blockchain holds transformative potential for HLIs, but successful adoption requires phased implementation, stakeholder engagement, and standardized governance, alongside further empirical validation and longitudinal research to assess long-term impacts.

Supporting this, a content validity assessment of the knowledge Integration (KI) model using Aiken's V method, validated through expert reviews, identified which proposed items demonstrated strong content alignment and which needed revision or removal [12]. The model, developed through systematic literature review and expert consultation, comprised 50 items across six constructs: technology factors, organizational factors, environmental factors, knowledge

integration, perceived usefulness, and blockchain adoption likelihood. Seven domain experts assessed each item for relevance and clarity on a 5-point Likert scale. Findings showed that 21 items required revision or removal (Aiken's $V < 0.70$), 21 were acceptable with minor revisions, and 8 demonstrated strong content validity ($V \geq 0.80$). The study underscores the importance of rigorous expert validation in refining measurement instruments to ensure construct alignment and reliability. The validated framework serves as a robust tool for assessing institutional readiness and guiding blockchain adoption strategies in higher education contexts.

Beyond conceptual models, numerous prototypes and initiatives illustrate how blockchain is being operationalized in educational settings. For instance, EduCTX is a decentralized platform aligning with the European Credit Transfer and Accumulation System (ECTS), designed for globally trusted student credit tracking [13]. Similarly, the Cerberus system employs smart contracts to streamline credential verification and combat fraud, offering efficient and privacy-aware validation of academic degrees [14].

Adoption of blockchain in academia varies widely due to institutional and stakeholder dynamics. Research in accounting education, for instance, applied the Technology Acceptance Model (TAM) to explore influencing factors such as perceived usefulness and organizational support, finding that institutional backing significantly moderates adoption intent [15]. Survey data from 314 accounting students in Yemeni universities were analyzed through structural equation modeling (SEM). The findings revealed that perceived usefulness, perceived ease of use, and facilitating conditions significantly predicted students' intentions to adopt blockchain. Additionally, awareness and trust in blockchain technology positively affected perceived usefulness and ease of use. The study highlights that enhancing technological infrastructure, integrating blockchain-related content into curricula, and fostering awareness can strengthen adoption readiness in educational settings. Moreover, broader literature emphasizes challenges like scalability, interoperability, regulatory barriers, and resistance from stakeholders as persistent obstacles to widespread adoption. [16] examined blockchain technology adoption in Malaysian higher education institutions by integrating the Technology Acceptance Model (TAM) and the Technology–Organisation–Environment (TOE) framework. Using a survey of academic and administrative staff, the study analyzed the influence of technological (relative advantage, compatibility), organizational (top management support, resources), and environmental (government support, competitive pressure) factors on adoption intention. Structural equation modeling (SEM) results indicated that technological and organizational factors had significant positive effects on adoption, while environmental factors played a moderating role. The study recommends enhancing awareness, providing training, and establishing supportive policies to foster blockchain integration in higher education.

Taken together, the literature underscores both the theoretical promise and practical experimentation of blockchain integration in higher education. Given prior content validity, We expect acceptable Rasch person reliability (≥ 0.80), item reliability near (≥ 0.80), and essential unidimensionality with minor contrasts. While conceptual

models like the knowledge integration framework provide structural guidance, there is a scant empirical foundation addressing their psychometric properties. Existing applications demonstrate feasibility, but standardized instruments for assessing institutional readiness, integration depth, and stakeholder alignment remain underdeveloped. This gap foregrounds the need for rigorous measurement tools, validated through models such as Rasch analysis, to advance both research and practice in blockchain adoption within academic settings.

III. METHODOLOGY

A pilot test was conducted to assess the psychometric properties of a 50 item survey measuring the instrument of knowledge integration model of blockchain technology in higher learning institutions. The main objective of this pilot study is to identify the psychometric quality. Somehow, the questionnaire is expected to give a similar meaning (consistency) to all respondents. If not, some of the questions will be rephrased or removed based on the analysis after data collection in this pilot study. For that reason, consistency in response will be analyzed. In addition, pilot test is used to determine an expected outcome based on difficult and easy tasks from the respondent.

Scale reliability was first evaluated using SPSS 23.0, followed by construct validity assessment using the Rasch Measurement Model [17] in WINSTEPS 3.92.1. The Rasch model, grounded in Item Response Theory (IRT), converts ordinal-level Likert-type responses into interval-level measurements, allowing for more precise quantification of latent traits. It jointly estimates person ability (θ) and item difficulty (β) on a shared logit scale using the logistic function:

$$P(X = 1) = \frac{e^{(\theta - \beta)}}{1 + e^{(\theta - \beta)}}$$

This approach is based on three core assumptions: (i) unidimensionality which all items measure a single latent trait; (ii) local independence which responses are independent when the latent trait is controlled; and (iii) monotonicity – individuals with higher ability have a greater probability of endorsing more difficult items.

In Rasch measurement, pilot studies are typically conducted with small to moderate samples to calibrate and refine items before large-scale validation. According to [17], a minimum of 30–50 respondents is sufficient to obtain stable item calibrations within $\pm 1/2$ logit with 99% confidence, provided that the sample reflects the intended respondent population. In this study, 31 participants respondents were selected through purposive sampling, targeting academic staff, administrators, and postgraduate students who possess basic familiarity with blockchain concepts or digital innovation initiatives within higher learning institutions. This approach ensures that participants are knowledge-relevant and context-appropriate for the pilot phase, aligning with recommendations for targeted sampling in early Rasch instrument development [8].

The developed instrument comprises six constructs derived from the KIBCK model, designed to capture multidimensional aspects of blockchain knowledge

integration within higher learning institutions. Specifically, the constructs are: Technology Factors (11 items), Organizational Factors (12 items), Environment Factors (10 items), Knowledge Factors (6 items), Perceived Usefulness Factors (6 items), and Blockchain Adoption Factors (5 items) which summing to a total of 50 items. All items are measured using a five-point Likert agreement scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). For ease of traceability in the Rasch analysis and discussion, each item is coded with a prefix corresponding to its construct (e.g., A= Demographic, B = Technology Factors, C = Organizational Factors, D = Environment Factors, E = Knowledge Factors, F = Perceived Usefulness Factors, G = Blockchain Adoption Factors). This coding scheme allows for transparent reference throughout the analysis (e.g., items B5, C7, etc.), enhancing interpretability of the results and construct-level insights.

Rasch analysis included examining item and person fit statistics (infit and outfit mean-square values) to evaluate alignment with model expectations, generating a Wright Map to compare item difficulty with student ability, and conducting Principal Component Analysis (PCA) of residuals to test unidimensionality beyond the primary factor. Differential Item Functioning (DIF) analysis was also considered to detect potential item bias across demographic groups.

This rigorous validation process was undertaken to ensure that the instrument is psychometrically sound, reliable, and suitable for future large-scale educational research.

IV. FINDING AND DISCUSSION

A. Summary Statistic

The Rasch analysis of the blockchain knowledge integration model survey showed that the instrument had good internal consistency and was able to measure differences in participants' knowledge with reasonable precision.

The Rasch analysis of the pilot data showed (Figure 1) that the mean person measure was 89.20 logits, indicating a generally high ability level among respondents relative to the difficulty of the items. The person separation index was 2.17, with a person reliability of 0.82, demonstrating that the instrument could distinguish approximately three distinct levels of blockchain knowledge ability within the sample. The average person infit MNSQ (1.03) and outfit MNSQ (1.02) were close to the ideal value of 1.0, and corresponding ZSTD values were near zero, indicating that response patterns conformed well to Rasch model expectations.

For items, the mean item measure was 50.00 logits, centered as expected in Rasch scaling. The item separation index was 1.81, with an item reliability of 0.77, slightly below the recommended 0.80 threshold, most likely due to the relatively small sample size ($n = 31$). The average infit MNSQ (1.01) and outfit MNSQ (1.02) for items also closely approximated 1.0, with minimal ZSTD deviations, indicating that items functioned as intended according to the model.

Pilot_DATA_LATEST									
Person		31 INPUT		31 MEASURED		INFIT		OUTFIT	
	TOTAL	COUNT	MEASURE	REALSE	INMSQ	ZSTD	OMNSQ	ZSTD	
MEAN	185.0	50.0	89.20	6.67	1.03	.1	1.02	-.1	
P.SD	14.8	.0	21.18	5.86	.34	1.5	.74	1.3	
REAL RMSE	8.88	TRUE SD	19.23	SEPARATION	2.17	Person RELIABILITY		.82	
Item		50 INPUT		50 MEASURED		INFIT		OUTFIT	
	TOTAL	COUNT	MEASURE	REALSE	INMSQ	ZSTD	OMNSQ	ZSTD	
MEAN	114.7	31.0	50.00	5.02	1.01	.1	1.02	.1	
P.SD	5.9	.0	10.75	1.39	.34	.8	.92	.8	
REAL RMSE	5.21	TRUE SD	9.40	SEPARATION	1.81	Item RELIABILITY		.77	

Figure 1. Summary Statistic

Overall, the results indicate that the instrument demonstrates good person reliability and acceptable item reliability for a pilot study. Both person and item fit statistics fall within acceptable ranges, suggesting that the instrument is psychometrically sound. However, increasing the sample size in subsequent studies is recommended to improve the stability of item difficulty estimates and to strengthen construct validity.

B. Identifying Misfit Items/Person

In Rasch analysis, there are several indices and criteria for quality control to check whether any items or respondents misfit the model. *Item fit* refers to how well an item functions in measuring the intended trait, as indicated by fit statistics; a misfitting item may be one that is too difficult or too easy for respondents or is not truly measuring the intended latent trait. Similarly, *person fit* indicates whether an individual's pattern of responses fits the model's expectations; an irregular or erratic response pattern by a person can signal a misfitting person (for example, if a student answers easy items incorrectly but hard items correctly, which defies the expected pattern).

According to [18], the following criteria can be used to identify misfit in Rasch data (for survey-type rating scale instruments):

- Point-measure correlation (PTMEA CORR): should be between 0.4 and 0.8 for productive items. Values outside this range may indicate an item that is not in line with the overall measurement.
- Outfit Mean Square (MNSQ): acceptable range is roughly 0.5 to 1.5 for surveys (with ideal range often cited as 0.7 to 1.3 for most measurements).
- Outfit Z-standard (ZSTD): acceptable range is approximately -2.0 to $+2.0$.

1) Person Fit Analysis

The Rasch Person Statistics: Misfit Order analysis revealed a mean person measure of 89.20 logits ($SD = 21.18$), with a person separation index of 2.17 and reliability of 0.82, indicating a good spread of ability levels and satisfactory measurement precision. However, several respondents exhibited notable misfit patterns.

Four responses, which are P25, P30, P20, and P24 are demonstrated high misfit, as indicated by outfit mean-square (MNSQ) values exceeding 1.5 and standardized Z-scores greater than +2.0, suggesting erratic or inconsistent response patterns that may result from misunderstanding certain items, guessing, or disengagement. Notably, P20 and P25 also recorded very low point-measure correlations (0.15 and 0.19, respectively), indicating weak alignment between their responses and the intended construct. Three additional respondents which are P19, P27, and P01 are displayed moderate misfit, with MNSQ values and Z-scores slightly above acceptable ranges, suggesting partial inconsistency in responses.

In contrast, several respondents showed overfit patterns (very low MNSQ), indicating overly predictable responses, which, while not as critical as underfit, may signal mechanical answering or lack of engagement. Addressing high-misfit respondents through response review or follow-up clarification could improve the overall validity and reliability of the dataset.

Person: REAL SEP.: 2.17 REL.: .82 ... Item: REAL SEP.: 1.81 REL.: .77

Person STATISTICS: MISFIT ORDER

ENTRY NUMBER	TOTAL SCORE	TOTAL COUNT	JMLE MEASURE	MODEL S.E.	INFIT MNSQ	OUTFIT ZSTD	PTMEASUR-AL CORR.	EXACT MATCH OBS%	Person				
25	198	50	105.05	7.33	1.14	.42	4.18	2.03	A-.15	.19	96.0	96.0	P25
30	186	50	81.14	3.26	1.91	2.98	1.54	1.48	B .40	.42	78.0	75.8	P30
20	182	50	77.27	2.98	1.48	1.82	1.64	1.98	C .15	.45	60.0	71.6	P20
24	145	50	56.05	2.44	1.61	2.63	1.64	2.69	D .56	.60	48.0	53.2	P24
12	163	50	64.45	2.31	1.46	1.91	1.24	1.13	E .71	.54	56.0	59.4	P12
1	168	50	67.26	2.43	1.25	1.11	1.31	1.38	F .34	.52	48.0	61.6	P01
15	180	50	75.56	2.87	1.26	1.09	1.03	.20	G .55	.46	68.0	70.0	P15
19	184	50	79.12	3.10	1.16	.70	1.22	.76	H .20	.43	62.0	73.5	P19
27	177	50	73.21	2.73	1.21	.93	.97	-.03	I .69	.48	68.0	66.8	P27
6	192	50	88.89	4.02	1.20	.73	.60	-.77	J .52	.34	90.0	84.4	P06
18	195	50	94.72	4.87	1.20	.61	1.19	.50	K .10	.28	90.0	90.1	P18
16	183	50	78.18	3.04	.86	-.52	1.03	.20	L .40	.44	76.0	72.7	P16
8	198	50	105.05	7.33	1.00	.22	.53	-.16	M .22	.19	96.0	96.0	P08
4	196	50	97.33	5.36	.93	-.02	.49	-.55	N .35	.26	92.0	92.1	P04
17	197	50	100.60	6.09	.92	.02	.61	-.19	K .29	.23	94.0	94.0	P17
7	188	50	83.38	3.44	.89	-.36	.71	-.71	J .44	.40	76.0	78.7	P07
22	194	50	92.51	4.52	.86	-.30	.53	-.73	I .43	.31	88.0	88.2	P22
3	193	50	90.60	4.24	.84	-.42	.70	-.43	H .42	.32	88.0	86.3	P03
13	189	50	84.61	3.56	.83	-.61	.63	-.93	G .49	.38	78.0	80.1	P13
9	179	50	74.75	2.82	.81	-.79	.71	-1.16	F .62	.47	76.0	68.8	P09
26	170	50	68.47	2.49	.59	-2.05	.77	-1.07	E .50	.51	70.0	63.0	P26
5	182	50	77.27	2.98	.73	-1.15	.65	-1.31	D .62	.45	82.0	71.6	P05
10	150	50	58.18	2.10	.55	-2.56	.60	-2.19	C .00	.58	70.0	55.5	P10
23	185	50	80.11	3.18	.60	-1.83	.50	-1.78	B .66	.42	84.0	74.3	P23
29	161	50	63.40	2.27	.45	-3.18	.49	-2.91	A .58	.55	74.0	59.3	P29
MEAN	185.0	50.0	89.20	6.49	1.03	.06	1.02	-.10			76.3	75.3	
P.SD	14.8	.0	21.18	5.94	.34	1.48	.74	1.34			13.8	12.7	

Figure 2. Person Fit Analysis

2) Item Fit Analysis

Based on the Rasch analysis output for Item Statistics: Misfit Order, the Figure 3 lists all 50 items ranked according to their misfit, with key indicators such as infit and outfit mean-square (MNSQ) values, standardized Z-scores (ZSTD), point-measure correlations, and exact match percentages. The mean item measure is set at 50.00 logits with a standard

deviation of 10.75, and the overall item reliability (REL) is 0.77 with a separation index of 1.81, indicating moderate spread and reliability in item difficulty.

Several items exhibit notable misfit, as shown by high outfit MNSQ values exceeding the commonly accepted range of 0.5–1.5 for productive measurement. For example, Item B5 (Entry 5) shows an outfit MNSQ of 2.73 and ZSTD of 4.21, indicating it behaves unpredictably compared to the model expectations and may not align well with the underlying construct. Similarly, Items B6, D8, and C7 also demonstrate outfit MNSQ values above 2.0 or infit/outfit ZSTD beyond ± 2.0 , suggesting potential misalignment or multidimensionality.

Point-measure correlations (PTMEASURE-AL CORR.) range mostly between 0.32 and 0.68, with lower correlations (e.g., 0.32 for B6) suggesting weaker relationships between item responses and the overall construct. Items with negative or very low correlations may be problematic. The exact match percentage (OBS%) varies widely from around 50% to over 88%, with items showing lower exact match potentially contributing to model misfit.

Figure 3 presents the items flagged for potential revision or removal based on Rasch fit criteria. Items B5, B6, D8, and C7 demonstrated high misfit, with outfit MNSQ values above 2.0 and ZSTD greater than +2.0, suggesting unpredictable response patterns. Items B4, C8, and D6 exhibited moderate misfit, warranting content and wording review. Additionally, F4 showed low point measure correlation (<0.40), indicating weaker alignment with the underlying construct. These items should be prioritised for revision, rewording, or replacement to enhance the instrument's measurement precision. In summary, while most items fit reasonably well within the Rasch model expectations, several items particularly B5, B6, D8, and C7 show notable misfit statistics and may require further review for content validity, clarity, or alignment with the construct. These items could be revised, reworded, or removed to improve the overall measurement quality. The moderate item reliability suggests the test measures the construct consistently, but improvements in item fit could enhance both precision and construct validity.

C. Wright Map

The Wright Map as illustrated in Figure 4 presents a side-by-side depiction of person abilities and item difficulties along the same logit measurement scale, allowing a clear visual comparison between the respondents' ability distribution and the instrument's difficulty range. The left side shows candidates, and the right side shows items. The left side of the map shows the distribution of the measured ability of the candidates from most able at the top to least able at the bottom. The items on the right side of the map are distributed from the most difficult at the top to the least difficult at the bottom. The mean person measure (M) is positioned well above the mean item measure, revealing that, on average, the respondents' ability levels surpass the difficulty levels of the items. This misalignment suggests that the test was relatively easy for the group, and the instrument may not be optimally challenging for respondents with higher abilities.

Person: REAL SEP.: 2.17 REL.: .82 ... Item: REAL SEP.: 1.81 REL.: .77

Item STATISTICS: MISFIT ORDER

ENTRY NUMBER	TOTAL SCORE	TOTAL COUNT	JMLE MEASURE	MODEL S.E.	INFIT MNSQ ZSTD	OUTFIT MNSQ ZSTD	PTMEASUR-AL CORR.	EXP.	OBSS% EXP%	Item
5	121	31	36.13	6.49	.97 .10	6.59 2.73	A .21	.32	88.0 88.2	B5
6	117	31	47.96	4.70	1.15 .51	2.91 2.29	B .32	.46	76.0 77.4	B6
1	118	31	45.62	4.97	1.90 .09	1.63 1.00	C .33	.43	84.0 79.6	B1
31	114	31	53.74	4.12	1.18 .60	1.81 1.56	D .38	.52	64.0 72.1	D8
8	119	31	42.98	5.32	1.80 1.72	.79 -.03	E .42	.40	92.0 82.3	B8
18	111	31	58.35	3.74	1.72 1.87	1.49 1.21	F .46	.57	64.0 67.0	C7
10	116	31	50.06	4.47	1.68 1.65	1.07 .31	G .47	.48	84.0 75.7	B10
4	115	31	51.98	4.28	1.64 1.61	1.08 .32	H .47	.50	76.0 74.1	B4
17	107	31	63.41	3.40	1.61 1.74	1.45 1.27	I .55	.62	48.0 62.7	C6
19	109	31	61.00	3.55	1.50 1.45	1.28 .82	J .52	.60	60.0 64.2	C8
40	117	31	47.96	4.70	1.48 1.23	1.15 .44	K .38	.46	72.0 77.4	F1
39	109	31	61.00	3.55	.97 .03	1.40 1.10	L .56	.60	68.0 64.2	E6
23	113	31	55.38	3.98	1.33 .97	1.11 .39	M .47	.54	68.0 70.2	C12
48	116	31	50.06	4.47	1.05 .26	1.31 .69	N .42	.48	76.0 75.7	G3
12	108	31	62.23	3.47	.97 .01	1.25 .77	O .59	.61	56.0 62.8	C1
47	111	31	58.35	3.74	.99 .09	1.16 .52	P .54	.57	68.0 67.0	G2
15	101	31	69.66	3.09	1.14 .56	1.10 .41	Q .67	.68	56.0 58.4	C4
33	114	31	53.74	4.12	1.08 .33	.86 -.16	R .52	.52	76.0 72.1	D10
16	102	31	68.69	3.13	1.07 .32	1.00 .11	S .68	.67	48.0 59.0	C5
2	120	31	39.89	5.80	1.06 .28	.47 -.42	T .43	.36	92.0 84.9	B2
26	114	31	53.74	4.12	.94 -.04	1.06 .29	U .49	.52	56.0 72.1	D3
35	120	31	39.89	5.80	1.06 .28	.88 .17	V .34	.36	84.0 84.9	E2
46	113	31	55.38	3.98	.97 .02	1.06 .29	W .53	.54	72.0 70.2	G1
50	117	31	47.96	4.70	.65 -.95	1.04 .26	X .52	.46	84.0 77.4	G5
14	102	31	68.69	3.13	.98 .02	1.02 .16	Y .68	.67	52.0 59.0	C3
34	121	31	36.13	6.49	.98 .12	.76 .14	Z .32	.32	88.0 88.2	E1
42	121	31	36.13	6.49	.98 .13	.70 .07	x .33	.32	88.0 88.2	F3
44	121	31	36.13	6.49	.98 .13	.70 .07	w .33	.32	88.0 88.2	F5
28	109	31	61.00	3.55	.79 -.59	.97 .02	v .62	.60	68.0 64.2	D5
21	109	31	61.00	3.55	.95 -.05	.92 -.12	u .62	.60	76.0 64.2	C10
45	122	31	31.17	7.68	.88 .00	.42 -.07	t .32	.27	92.0 92.1	F6
25	116	31	50.06	4.47	.87 -.25	.69 -.44	s .53	.48	76.0 75.7	D2
30	114	31	53.74	4.12	.84 -.36	.87 -.14	r .54	.52	64.0 72.1	D7
32	117	31	47.96	4.70	.86 -.26	.60 -.56	q .53	.46	84.0 77.4	D9
38	123	31	23.31	10.44	.84 .12	.24 -.34	p .27	.19	96.0 96.0	E5
20	98	31	72.43	2.99	.82 -.57	.78 -.73	o .74	.71	64.0 55.2	C9
13	107	31	63.41	3.40	.81 -.56	.80 -.52	n .68	.62	68.0 62.7	C2
49	114	31	53.74	4.12	.81 -.46	.73 -.49	m .58	.52	80.0 72.1	G4
11	121	31	36.13	6.49	.79 -.30	.37 -.39	l .41	.32	88.0 88.2	B11
3	119	31	42.98	5.32	.76 -.50	.50 -.52	k .48	.40	80.0 82.3	B3
37	119	31	42.98	5.32	.75 -.54	.61 -.32	j .46	.40	88.0 82.3	E4
36	121	31	36.13	6.49	.74 -.42	.59 -.05	i .39	.32	88.0 88.2	E3
7	119	31	42.98	5.32	.73 -.59	.60 -.33	h .47	.40	88.0 82.3	B7
24	117	31	47.96	4.70	.71 -.73	.60 -.55	g .53	.46	84.0 77.4	D1
29	117	31	47.96	4.70	.71 -.73	.58 -.60	f .53	.46	76.0 77.4	D6
27	115	31	51.98	4.28	.64 -1.02	.61 -.72	e .59	.50	80.0 74.1	D4
22	113	31	55.38	3.98	.56 -1.40	.47 -1.38	d .66	.54	80.0 70.2	C11
41	118	31	45.62	4.97	.56 -1.21	.41 -.88	c .56	.43	84.0 79.6	F2
43	120	31	39.89	5.80	.56 -1.07	.30 -.76	b .50	.36	92.0 84.9	F4
9	120	31	39.89	5.80	.54 -1.13	.29 -.80	a .51	.36	92.0 84.9	B9
MEAN	114.7	31.0	50.00	4.77	1.01 .09	1.02 .12			76.3 75.3	
P.SD	5.9	.0	10.75	1.37	.34 .85	.92 .78			12.5 9.8	

Figure 3. Item Fit Analysis

The range of item difficulties spans from E5, located at the bottom of the scale at approximately 20 logits (the easiest), to C9, the most difficult item, positioned around 70 logits. There is a strong concentration of items clustered between 50 and 60 logits, which provides good coverage for respondents with average abilities. However, there is a notable scarcity of items above 70 logits, leaving a substantial portion of high-ability respondents such as P02, P11, P14, and P28 without sufficiently challenging items. This creates a potential ceiling effect, where the highest-ability individuals achieve near maximum scores without the opportunity to fully demonstrate their ability. Furthermore, there is a clear measurement gap between approximately 90 and 100 logits on the item side, meaning that respondents such as P10 and P24, who fall within this range, have no items matched to their ability level. This gap may reduce the precision of measurement in that ability segment.

From a psychometric perspective, the Wright Map highlights both strengths and areas for improvement in the instrument's targeting. While the clustering of items in the middle range ensures strong measurement precision for average ability participants, the lack of very difficult items means the scale is less effective at differentiating high ability respondents. This imbalance could impact the validity of

conclusions drawn about the upper end of the ability spectrum. To address these limitations, it is recommended that more challenging items be developed to target the 70–110 logit range, thereby reducing the ceiling effect and closing measurement gaps. By doing so, the instrument would provide a more balanced difficulty distribution, improve the targeting of items to the full range of respondent abilities, and enhance the overall measurement precision of the scale.

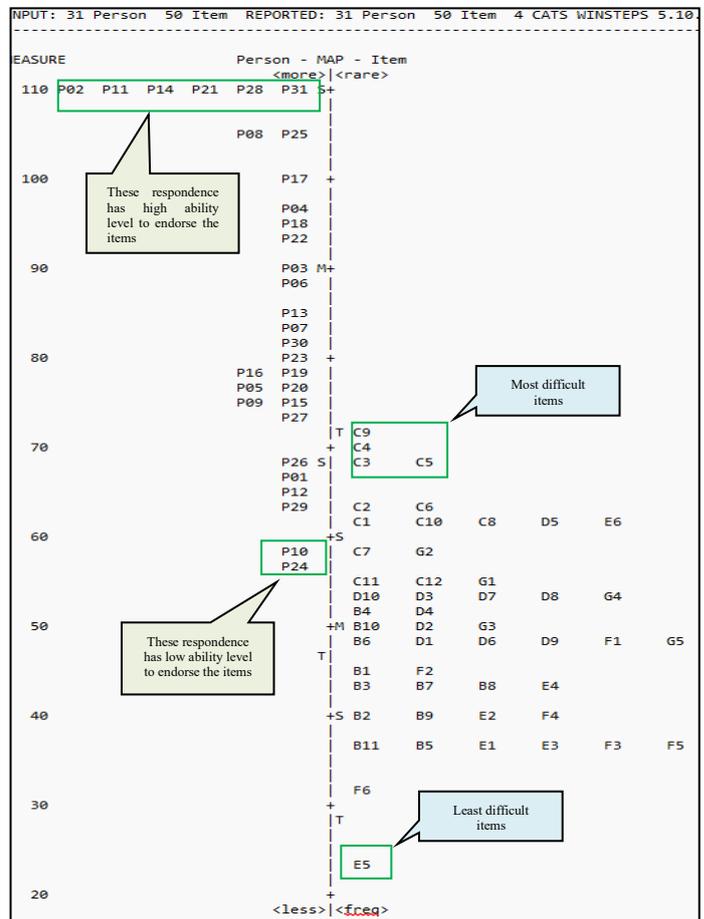


Figure 4. Wright Map Analysis Item and Person

D. Item Multidimensional

Unidimensionality analysis as demonstrated in Figure 5 is a key step in Rasch measurement to determine whether an instrument measures a single underlying construct as intended as illustrated in Figure 5. It examines the proportion of variance in the data explained by the Rasch measures (persons and items) compared to the variance remaining unexplained, which may indicate the presence of additional dimensions. In this study, the analysis showed that 40.2% of the total variance was explained by the measures, meeting the commonly accepted minimum threshold of 40% in social science research. The essential unidimensionality value was 57%, indicating that a dominant construct underlies the instrument. Variance explained by persons (21.6%) and items (18.7%) was close to the expected values, further supporting model fit. However, the first contrast in the unexplained variance was relatively high (eigenvalue = 6.96; 8.3%), exceeding the recommended benchmark of 2.0, suggesting a

possible secondary dimension. Subsequent contrasts also showed moderate residual variance, warranting further examination of item clusters contributing to this pattern. Overall, the results support the presence of a dominant construct, but item-level review is recommended to ensure stronger unidimensionality.

INPUT: 31 Person 50 Item REPORTED: 31 Person 50 Item 4 CATS WINSTEPS 5.10

Table of STANDARDIZED RESIDUAL variance in Eigenvalue units = Item info

	Eigenvalue	Observed	Expected
Total raw variance in observations =	83.6612	100.0%	100.0%
Raw variance explained by measures =	33.6612	40.2%	42.3%
Raw variance explained by persons =	18.0427	21.6%	22.7%
Raw Variance explained by items =	15.6185	18.7%	19.6%
Raw unexplained variance (total) =	50.0000	59.8%	100.0%
Unexplned variance in 1st contrast =	6.9644	8.3%	13.9%
Unexplned variance in 2nd contrast =	5.7427	6.9%	11.5%
Unexplned variance in 3rd contrast =	4.9630	5.9%	9.9%
Unexplned variance in 4th contrast =	4.2801	5.1%	8.6%
Unexplned variance in 5th contrast =	3.4650	4.1%	6.9%

Essential Unidimensional (Rasch/Common variance) = 57.0%

Figure 5. Item Multidimensional

IV. CONCLUSIONS

Based on the findings, this pilot study successfully validated an instrument grounded in the Knowledge Integration Model of Blockchain Technology for Higher Learning Institutions using the Rasch Measurement Model. The results demonstrated good person reliability (0.82) and acceptable item reliability (0.77), indicating that the instrument can distinguish varying levels of blockchain knowledge among respondents. Fit statistics generally fell within recommended ranges, though several items (e.g., B5, B6, D8, and C7) showed notable misfit and should be revised or removed to enhance measurement precision. The Wright Map analysis revealed that the items were relatively easy for participants, with a shortage of challenging items for high ability respondents, suggesting the need to develop more difficult items to avoid ceiling effects. Unidimensionality testing showed that while the instrument predominantly measures a single latent construct, secondary dimensions may exist, warranting further refinement to ensure conceptual clarity.

Overall, this pilot study demonstrates that the developed instrument based on the Knowledge Integration Model of Blockchain Technology in Higher Learning Institutions is a valid and reliable tool for measuring blockchain knowledge integration, with strong person reliability and acceptable item reliability. The Rasch analysis confirms that most items function as intended, though certain misfitting items require revision, and additional challenging items are needed to better target high ability respondents. While the instrument primarily measures a single construct, the presence of minor secondary dimensions highlights opportunities for refinement.

This pilot provides preliminary validation evidence for the KIBCK based instrument, demonstrating acceptable reliability and construct coherence while highlighting areas for refinement prior to large-scale validation. These findings provide a solid foundation for improving the instrument before large scale deployment, ultimately supporting more accurate assessment, monitoring, and strategic planning for blockchain adoption in higher education.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this paper.

ACKNOWLEDGEMENT

We would like to thank Universiti Sains Islam Malaysia (USIM) for the financial support provided through the USIM Research Grant (PPPI/USIM/TAMHIDI/USIM/112323), which made this study possible.

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APPENDIC

TABLE I. INSTRUMENT ITEM CODE DETAILS

ITEM CODE	ITEMS
B1	Blockchain ensures unauthorized parties cannot access academic records.
B2	Blockchain technology provides stronger data privacy than current systems.
B3	I trust blockchain to securely store my institution's credentials.
B4	Blockchain reduces risks of data breaches in education.
B5	Blockchain makes academic transactions (e.g., grading) more transparent.
B6	I can verify the authenticity of blockchain-stored records easily.
B7	Blockchain increases trust in shared knowledge (e.g., research data).
B8	Blockchain's transparency reduces conflicts over academic records.
B9	Blockchain prevents tampering with academic records.
B10	My institution's use of blockchain ensures accurate record-keeping.
B11	Historical changes to records are traceable via blockchain.
C1	My institution has the technical infrastructure to adopt blockchain.
C2	Budget is allocated for blockchain implementation.
C3	Staff are trained to use blockchain-based systems.
C4	My institution has a clear roadmap for blockchain integration.
C5	Administrators actively promote blockchain initiatives.
C6	Leadership addresses concerns about blockchain adoption.
C7	Faculty are encouraged to pilot blockchain tools.
C8	Leadership prioritizes blockchain adoption in strategic plans.
C9	My institution can afford blockchain implementation costs.
C10	IT teams are skilled in maintaining blockchain systems.
C11	Blockchain tools are compatible with existing IT systems.
C12	External funding (e.g., grants) supports blockchain projects.
D1	National policies encourage blockchain use in education.

D2	Legal frameworks support blockchain-based academic credentials.
D3	Government funding is available for blockchain initiatives.
D4	My institution complies with regulations for blockchain adoption.
D5	My institution partners with tech firms for blockchain solutions.
D6	Joint research projects use blockchain for knowledge sharing.
D7	Employers recognize blockchain-verified credentials.
D8	Employers prefer candidates with blockchain-stored degrees.
D9	Public awareness of blockchain benefits in education is growing.
D10	Society pressures institutions to adopt transparent technologies.
E1	Blockchain supports interdisciplinary knowledge development.
E2	Access to shared knowledge is equitable across departments/institutions.
E3	Archived knowledge is easily retrievable via blockchain.
E4	Research findings are implemented faster via blockchain.
E5	Blockchain platforms enable real-time sharing of course materials across departments.
E6	My institution uses blockchain to track the impact of knowledge on community projects.
F1	Blockchain saves time in credential verification.
F2	Using blockchain enhances my productivity as a staff/educator/student.
F3	Blockchain simplifies administrative processes (e.g., transcript requests).
F4	Blockchain adds value to my institution's knowledge management.
F5	Automated smart contracts (e.g., for research royalties) improve workflow efficiency.
F6	Blockchain increases transparency in research data sharing and citation tracking.
G1	My institution plans to expand blockchain use beyond credentials (e.g., research, administration).
G2	My institution currently uses blockchain for any academic processes (e.g., credentials, research).
G3	Blockchain offers significant advantages over our current record-keeping systems.
G4	Blockchain adoption has improved our institution's operational efficiency.
G5	Blockchain supports my institution's alignment with national digital education goals (SDGs).